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Up-Gradation Of Lathe Machine To Turn Milling Machine Using CNC.

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Abstract: The up-gradation of a conventional lathe machine into a versatile turn-milling machine. The project involved a meticulous retrofitting process, incorporating cutting-edge technologies such as Variable Frequency Drives (VFDs), motor drives, servo motors, and ball screws. The integration of these advanced components aimed to significantly enhance the machine's capabilities, precision, and overall performance. The VFDs played a pivotal role in enabling precise control over the spindle speed, facilitating a wider range of machining operations. The incorporation of motor drives ensured smooth and efficient power transmission to the machine's components, contributing to improved productivity. The implementation of servo motors provided precise control over the X and Z axes, enabling complex milling operations with exceptional accuracy. Finally, the installation of ball screws replaced the traditional lead screws, resulting in smoother motion, reduced backlash, and enhanced positional accuracy.

Through this up-gradation, the lathe machine was transformed into a multifunctional turn-milling machine, capable of handling a broader spectrum of manufacturing tasks. The project not only showcased the potential of retrofitting existing machinery but also demonstrated the effectiveness of integrating modern technologies to revitalize conventional manufacturing processes.

Introduction

The advent of the Industrial Revolution marked a significant leap in manufacturing processes, with the lathe machine emerging as a cornerstone tool. Its ability to shape and contour materials has been instrumental in various industries. However, as technology advances and manufacturing demands become increasingly complex, the need for more versatile and efficient machines has arisen. One such evolution is the integration of milling capabilities into lathe machines, transforming them into turn-milling machines. This paper explores the potential of retrofitting conventional lathe machines with advanced technologies like ball screws, motor drives, variable frequency drives (VFDs), stepper motors, and Computer Numerical Control (CNC) systems. [6]

The need for up-gradation enhanced productivity is to traditional lathe machines often face limitations in terms of machining speed and accuracy. Upgrading to a turn-milling machine can significantly boost productivity by allowing for simultaneous turning and milling operations. [7] To expand machining capabilities a turn-milling machine offers a wider range of machining operations, including drilling, tapping, and slotting, which can reduce the need for multiple machines and setups, Following are the considerations

- Improved Precision and Accuracy: The integration of CNC technology and highprecision components like ball screws enables precise control over tool paths and feed rates, resulting in improved part accuracy and surface finish.

- Flexibility and Adaptability: CNCcontrolled turn-milling machines can easily adapt to changing production requirements, facilitating the manufacturing of complex parts with varying geometries.
- Cost-Effectiveness: While purchasing a new turn-milling machine can be a significant investment, retrofitting an existing lathe machine can be a more costeffective solution, especially for small and medium-sized enterprises.

➢ Key Technologies for Up-gradation:

1. Ball Screws: Ball screws offer high efficiency, precision, and durability compared to traditional lead screws. They are essential for accurate positioning and motion control in turn-milling machines.
2. Motor Drives: Powerful motor drives are crucial for powering the spindle and feed axes of the machine. They provide precise control over speed and torque, enabling efficient machining operations.
3. Variable Frequency Drives (VFDs): VFDs allow for stepless speed control of the spindle motor, optimizing cutting parameters for different materials and operations.
4. Stepper Motors: Stepper motors are ideal for positioning the tool and workpiece accurately, providing precise control over movement in small increments.
5. CNC Systems: CNC systems enable automated control of the machine's axes, allowing for complex part programming and execution.

➢ Potential Benefits of Up-gradation:

1. Increased Production Capacity: Reduced setup times, faster machining cycles, and simultaneous operations can significantly boost production output.
2. Improved Part Quality: Enhanced accuracy, precision, and surface finish can lead to higher-quality products.
3. Reduced Labor Costs: Automation and CNC control can minimize the need for skilled operators, leading to cost savings.
4. Enhanced Flexibility: The ability to handle a wider range of part geometries and materials can improve adaptability to changing market demands.
5. Extended Machine Lifespan: Modernization and retrofitting can extend the useful life of existing lathe machines.

It aims to provide a comprehensive overview of the various aspects involved in upgrading a lathe machine to a turn-milling machine.

I. Literature survey:

1. Title: Study of performance of milling machine for optimum surface roughness.
   Authors: Sanjay Kumar Mishra and Shabana naz Siddique.
   Author says, Milling process is used to remove material by a rotating cutter. This process of machining is used by the industries usually, and by cutting away the material which is unnecessary. Milling machine is used to produce a variety of character on a part. Central workshop of Bhilai Institute of Technology Durg which is the top most engineering collage of central India has two milling machines which are used to perform practical's of engineering students. The aim of this paper is to get optimum surface roughness, which identify the parameter of machine. Surface roughness is one of the most specific consumer requirements in a machining process. Surface roughness actually means fine irregularities of surface texture. These parameters are focussed on by many researchers and it is found that the process parameter cutting speed, depth of cut and feed are critical parameters which influence the surface roughness of work piece. So from optimization point of view, these three process parameter (feed, cutting depth and speed of cutting) should be selected. A suitable method of optimization is needed to find optimum value of parameters for cutting and minimizing roughness of surface. Taguchi method will be used to get optimum surface roughness. [2]

2. Title: Review on Milling Machine
   Authors: Shri Bhagwan.
   The author of this study explains, milling process is used to remove material by a rotating cutter. This machining procedure is commonly employed by industries, and it involves cutting away any unneeded material. On a part, a milling machine is used to create a variety of characters. a goal of this research is to determine the optimum surface roughness, which is a machine parameter. One of the most particular customer needs in a machining process is surface roughness. Surface roughness refers to minor texture abnormalities on the surface. In the machining process, surface roughness is also caused by the tool chip contact and feed marks. In measuring the productivity of machine tools and machined products, the quality of the surface plays an essential role. Several milling process factors, including as cutting speed, feed, cutting depth, rate of material removal, also known as MRR, and machine time, all play a crucial impact in surface roughness. Many investigations have focused on these factors, and it has been discovered that the process parameters cutting speed, depth of cut, and feed are essential characteristics that determine the work piece's surface roughness. [3]

3. Title: Prototype Development of Milling Machine using CAD/CAM: A Review.
   Author: Prajakta Dahake and Nikita Saharkar
   This work enables the development of unmanned machining systems has been a recent focus of manufacturing research. The conventional milling machine removes metal with a revolving cutting tool called a milling cutter. For this, CNC machines are in use. CNC machine operates on part program. This program includes several G-codes and M-codes. This program is generated by skilled operators. This may cause error in geometry. Also increases labor cost. Thus new technology of milling operation is conceptualized to reduce these problems using CAD/CAM. In this, firstly part design is created in CAD software like CATIA, ProE etc. This part design is fed in CAM software. Accordingly, coordinates forms. Also program is generated. According to that program, cutting tool operates to produce required part. [4]

4. Title: Dynamic Analysis of Lathe Machine Tool.
   Author: Darina Hroncova, Peter sivak, Jozef Filas, Michal Kicko.
   The thesis presents a theoretical analysis of the task, while practical knowledge of selected parts of the dynamics is used to solve individual involved transfers. Further for the two types of programs includes detailed diagrams that is rev/min (rpm) increasing and rev/min reduction. The centre lathe is the object of exploring. Specifically transmission parts such as shafts, gears and pulleys then it is electric drive device, and finally driven parts such as spindle and chuck. Analyze of angular velocities, moments of inertia, kinetic energy, performance and labor of each part of the kit is performed using reduction method, and the system is reduced to a first member, which is an electric motor. We have developed integration of individual gears for the machining modes. Specifically for conventional turning 2800 rpm and for winding springs 14 rpm. In technical practice it is not possible to measure two same results of performance parameters, for reason of passive resistance. [5]

5. Title: A study on Types of Lathe Machine and Operations: Review.
   Author: Hiren Patel, IA Chauhan
   In this article, the review of this paper pertaining to the present research topic has been carried out to gain knowledge and to become familiar with the established techniques and methodology. Types of Lathe Machine and its Operations is a term that covers a large collection of manufacturing processes designed to remove unwanted material, usually in the form of chips, from a work-piece by different types of lathe machines. It also covers action of individual lathe. Machining is used to convert castings, forgings, or preformed blocks of metal into desired shapes, with size and finish specified to fulfil design requirements. Almost every manufactured product has components that require machining. The basic lathe that was designed to cut cylindrical metal stock has been developed further to produce screw threads, tapered work, drilled holes, knurled surfaces and crankshafts. The typical lathe provides a variety of rotating speeds and a means to manually and automatically move the

cutting tool into the work-piece. Machinists and maintenance shop personnel must be thoroughly familiar with the lathe and its operations to accomplish the repair and fabrication of needed parts. [6]

II. PROPOSED DESIGN:

THE FOLLOWING FIGURE SHOWS WORK STRUCTURE:

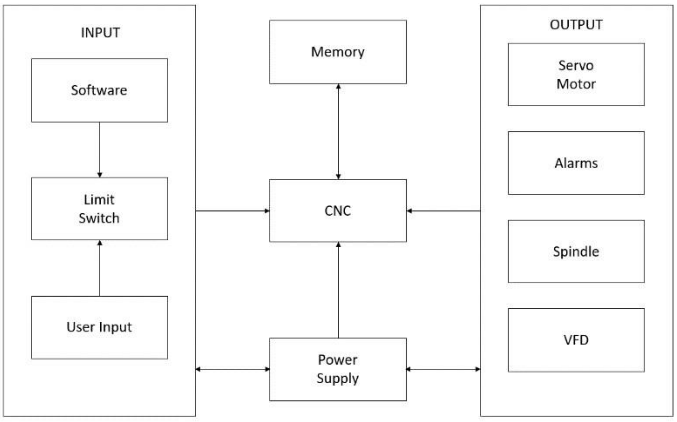

Fig. Block Diagram

- **Variable Frequency Drive (VFD):** A device that controls the speed of an electric motor by adjusting the frequency of the power supply. This allows for precise control and energy savings.

Figure 3.2: Variable Frequency Drive.

- **Computerized Numerical Control (CNC):** A system that uses computer software to control the movement of machine tools, such as lathes and mills, to create complex parts with high precision.

Figure 3.3: Computerized Numeric Control.

- **CNC Programming Display:** The interface on a CNC machine where the operator inputs the program instructions, monitors the machine's status, and views the part's design.

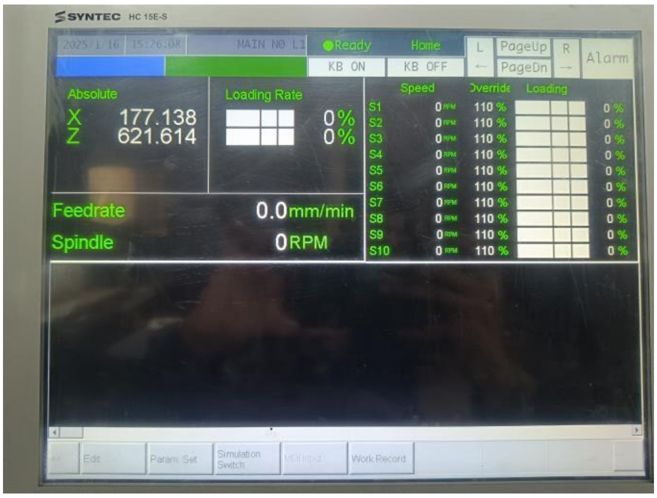

Figure 3.4: Computerized Numeric Control programming display.

- **Servo Motor:** A precise motor that provides accurate positioning and speed control, often used in robotics and automation.


Figure 3.5: Servo motor.

- **Panel Wiring Diagram:** A schematic representation of the electrical connections within a control panel, showing the components, wires, and their interconnections.

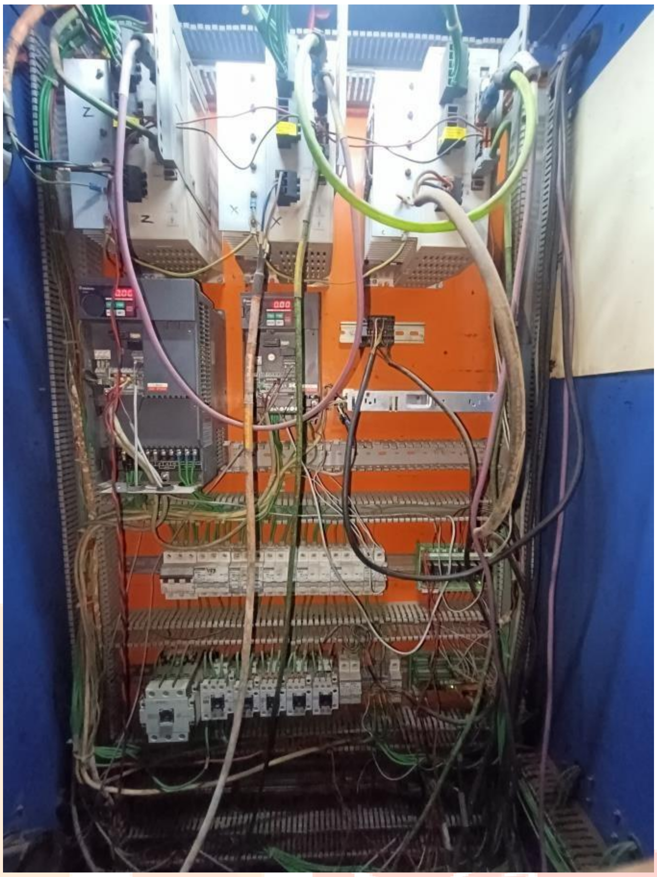

Figure 3.6: Panel Wiring Diagram.

III. Proposed Methodology:

- Analyze the Existing Lathe Machine: Identify the mechanical and operational limitations of the current lathe. Examine the compatibility of existing components (spindle, bed, carriage, etc.) for turn-milling operations.
- Define the Upgrade Requirements and Input Enhancements: Software: Install CNC software capable of handling turn-milling operations. Examples include Fanuc, Siemens, or Mach3.

Figure 4.1: Generic CNC.

- User Input: Integrate a user-friendly control panel or interface for manual programming and control
- Limit Switches: Add limit switches for position feedback and enhanced safety.
- Servo Motors: Replace or add servo motors to control rotational and linear motions precisely.
- Spindle: Upgrade the spindle for multidirectional milling and turning compatibility.
- VFD (Variable Frequency Drive): Use a VFD to regulate spindle speeds for various operations.
- Alarms: Implement alarms for fault detection and safety warnings.
- Develop the CNC Control System: Utilize a CNC controller as the central component to integrate all inputs (limit switches, user inputs, and software) and outputs (servo motors, spindle and alarms).

- Integrate a memory unit for storing G-code programs required for turnmilling operations.
- Electrical and Mechanical integration: Power Supply: Ensure a reliable power supply to support high-power components like servo motors and the spindle. Implement voltage stabilization for consistent operation.
- Testing and Calibration: Test each subsystem (input, control, output) for functionality and integration. Calibrate the axes, spindle speed, and tool positions for accuracy.
- Programming and Training: Develop Gcode programs for turn-milling operations. Train operators to use the upgraded machine efficiently.
- Final Validation: Perform test runs with various work

IV. Conclusion:

This article has delved into the feasibility and potential benefits of upgrading a conventional lathe machine into a turn-milling machine using modern components like ball screws, stepper motors, motor drives, spindles, and variable frequency drives. The proposed modifications aim to enhance the machine's precision, versatility, and overall performance.

The analysis suggests that such an upgrade is technically viable and could significantly improve the machine's capabilities. The use of ball screws would lead to greater accuracy and smoother motion, while stepper motors and motor drives

would enable precise control over spindle speed and feed rates. The incorporation of a variable frequency drive would further enhance the machine's flexibility by allowing for a wider range of spindle speeds.

However, the successful implementation of this upgrade would require careful consideration of various factors, including the mechanical design, electrical integration, and software programming. Additionally, the economic feasibility of the project would need to be assessed, taking into account the costs of components, labor, and potential downtime.

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